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(54) IMPROVEMENTS IN PROPELLER FASTENING

(71) We, PILGRIM ENGINEERING DEVELOPMENTS LTD., a British Company, of Beaufort House, Gravel Lane, London E.C.3., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a propeller-mounting assembly and to a method for securing a propeller on a tailshaft of a ship.

To secure a propeller on a tailshaft it is common practice to produce a friction grip between a tapered portion on the tailshaft and a tapered bore in the propeller, by pushing the propeller along the tailshaft. When the propeller has been pushed on the tailshaft a nut is screwed on the end of the tailshaft to abut the propeller thereby ensuring that the propeller cannot move towards the rear of the tailshaft even when the propeller is providing reverse thrust for the ship. The invention provides a method for securing a propeller on a tailshaft without the use of a nut.

According to the invention in a first aspect there is provided a method for mounting a propeller on a tailshaft of a ship, the method comprising the steps of arranging the propeller on the tailshaft such that a bore in the propeller, or in a metallic sleeve fixed within the propeller, which tapers towards the rear of the propeller engages a complementary tapered portion on the tailshaft, arranging a tyre around the tailshaft in an annular recess which extends forward of the rear face of the propeller whereby the tyre is constrained against expansion in a radial direction, the forward face of the tyre engaging the propeller, or a metallic sleeve fixed within the propeller, and the rear face of the tyre engaging an annular abutment member arranged around the tailshaft, constraining the annular abutment member against movement towards the rear of the tailshaft by mounting a split shear-ring in an annular groove in the tailshaft to the rear of the annular abuntment member, and pumping fluid into the tyre whereby it expands and urges the propeller and the annular abutment member apart thereby pushing the propeller along the tailshaft and developing a friction grip between the tapered bore in the propeller or in a metallic sleeve fixed within the propeller and the tapered portion on the tailshaft.

In a preferred embodiment of the invention the method further includes the steps of providing a substantially cylindrical bore in the propeller, positioning a metallic first sleeve co-axially within the bore in the propeller, the first sleeve having a substantially cylindrical outer surface of smaller diameter than the bore in the propeller and an inner surface which tapers towards the rear of the propeller, fixing the first sleeve in the bore in the propeller by injecting a hardenable compound into the space between the first sleeve and the bore and subjecting the compound to a pressure substantially greater than atmospheric pressure until it hardens, providing a substantially cylindrical outer surface on the tailshaft, mounting on the tailshaft a closely-fitting metallic second sleeve having a tapered outer surface complementary to the tapered inner surface of the first sleeve, and pushing the first sleeve, with the propeller, on the second sleeve with sufficient force to provide a friction grip between the first sleeve and the second sleeve and between the second sleeve and the tailshaft.

In this preferred embodiment the complementary tapered surfaces required to produce a friction grip are provided on two metallic sleeves, a first sleeve fixed in a substantially cylindrical bore in the propeller and a second sleeve mounted on a substantially cylindrical tailshaft. In this way a large area of contact between the tapered surfaces can be obtained. The tapered surfaces can be machined on the same machine at the same setting, giving for example a 1 in 20 taper, and then bedded together by mounting the first sleeve on the second sleeve before the first sleeve is mounted on the tailshaft. It is also advantageous for the first sleeve to be

supported by the second sleeve during the process of fixing the first sleeve in the bore in the propeller. To develop a friction grip between the first sleeve and the second sleeve and between the second sleeve and the tailshaft, the first sleeve is pushed along the second sleeve using a tyre as described above, the forward face of the tyre engaging the first sleeve.

According to the present invention in a second aspect there is provided a method for mounting a propeller on a tailshaft of a ship, the method including the steps of arranging the propeller on the tailshaft such that a bore in the propeller, or in a metallic sleeve fixed within the propeller, which tapers towards the rear of the propeller engages a complementary tapered portion on the tailshaft, arranging a tyre around the tailshaft such that the forward face of the tyre engages the propeller or a metallic sleeve fixed within the propeller and the rear face engages an annular abutment member arranged around the tailshaft, constraining the annular abutment member against movement towards the rear of the tailshaft by mounting a split shear-ring in an annular groove in the tailshaft to the rear of the annular abutment member, pumping fluid into the tyre whereby it expands and urges the propeller and the annular abutment member apart thereby pushing the propeller along the tailshaft and developing a friction grip between the tapered bore in the propeller and the tapered portion of the tailshaft, releasing the fluid from the tyre, and urging apart the annular abutment member and the split shear-ring whereby the annular abutment member is caused to abut against the propeller with sufficient force to ensure that the propeller does not move towards the rear of the tailshaft during normal use.

According to the present invention in a third aspect there is provided an assembly of a propeller on a tailshaft, the propeller, or a metallic sleeve fixed within the propeller, having a bore which tapers towards the rear of the propeller and which engages a complementary tapered portion on the tailshaft, a tyre being arranged around the tailshaft in an annular recess which extends forward of the rear face of the propeller whereby the tyre is constrained against expansion in a radial direction, the forward face of the tyre engaging the propeller, or a metallic sleeve fixed within the propeller, and the rear face of the tyre engaging an annular abutment member which is arranged around the tailshaft and is constrained against movement towards the rear of the tailshaft by a split shear-ring located in the rear of the annular abutment member in an annular groove in the tailshaft, whereby the propeller can be pushed along the tailshaft by pumping fluid into the tyre.

The invention will be further described by way of example and with reference to the accompanying drawings, in which:—

Fig. 1 is a fragmentary longitudinal section through a propeller secured on a tailshaft of a ship using a method according to the invention;

Fig. 2 is another longitudinal section through the propeller and tailshaft shown in Fig. 1 at a different stage in the method;

Fig. 3 is an end view of the arrangement shown in Fig. 2;

Fig. 4 is a longitudinal section through an alternative arrangement of a propeller secured on a tailshaft using a method according to the invention; and

Fig. 5 is another longitudinal section through the arrangement shown in Fig. 4 on an enlarged scale at a different stage in the method.

Referring to Figs. 1, 2 and 3, a propeller 10 is arranged on the aft end of a tailshaft 11 of a ship. The outer surface of the aft portion of the tailshaft 11 and the inner surface of the bore in the propeller 10 are tapered. To push the propeller 10 along the tapered tailshaft 11, a flat tyre 12 of nitrile rubber is arranged around the tailshaft in an annular recess 13 in the after end of the propeller boss formed by a parallel-sided counterbore in the propeller. The forward face of the tyre 12 abuts the end of the recess 13. The tyre is constrained in the radial direction between, on the outside, the cylindrical wall of the recess and, on the inside, the tailshaft. The rear face of the tyre 12 engages, or is integral with, a ring 14 of harder rubber, the rear face of the ring 14 engaging the forward end of an annular abutment member 15.

The forward part 15′ of the annular abutment member 15 is of smaller diameter than the rear part 15″ in order to fit into the recess 13.

To the rear of the annular abutment member 15 is a split shear-ring 16 located in an annular groove 17 in a cylindrical stern-most part of the tailshaft 11. The shear-ring 16 is split along a diameter to enable it to be fitted in the groove 17 and bolts 18 passing through the split shear-ring into threaded holes 22 in the annular abutment member are required to fix the ring 16 to the annular abutment member 15 and maintain the ring in the groove 17.

In Fig. 1 the parts are shown arranged in preparation for pushing the propeller 10 along the tailshaft 11. The split shear-ring 16 abuts the rear shoulder of the annular groove 17. A pump (not shown) is used to fill the tyre 12 with hydraulic oil through a channel 19 in the annular abutment member 15. The tyre 12 cannot expand in a radial direction because it is a close fit in

the recess 13. The tyre expands in an axial direction and pushes the propeller 10 along the tailshaft 11 up the tapered portion to provide a friction fit on the tailshaft.

When the propeller 10 has been pushed along the tailshaft the desired distance, the hydraulic pump is disconnected and oil is bled away from the tyre. The friction grip developed between the propeller and the tailshaft ensures that the propeller does not move during this operation. The annular abutment member 15 is moved forward along the tailshaft 11 so that the forward end of the portion 15″ of larger diameter abuts the aft face of the propeller 10. The bolts 18 are unscrewed to enable the split shear-ring 16 to be removed and replaced on the tailshaft in a reversed orientation in which the surface which originally faced astern faces forward. When the split shear-ring 16 is replaced on the tailshaft it is rotated relative to the annular abutment member 15 such that the bolts 18, which originally engaged threaded holes 22 in the annular abutment member, can pass with clearance through larger holes 23 in the annular abutment member to engage threaded holes 21 in the propeller 10. It should be noted that Fig. 1 is a longitudinal section passing through the threaded holes 22 and Fig. 2 is a section passing through the larger holes 23. When the split shear-ring has been correctly positioned the bolts 18 are partly screwed into the holes 21 in the propeller in order to maintain the shear-ring in place in the annular groove 17. The shear-ring 16 has a counterbore 16′ in one side of larger diameter than the cylindrical aft portion of the tailshaft so that when it is in the initial orientation the counterbore enables the shear ring to overhang the cylindrical portion of the tailshaft aft of the groove 17. When the shear ring 16 is replaced in the reversed orientation with its then aft-most face abutting the aft shoulder of the annular groove 17 it is set further forward so that there is only a small distance between the forward face of the shear-ring and the rear face of the annular abutment member 15. The assembly of propeller 10, annular abutment member 15 and split shear-ring 16 is made rigid by means of grub screws 20 which run in threaded bores in the split shear-ring. The screws 20 are parallel to the axis of the tailshaft 11 and can be screwed forward through the split shear-ring 16 to engage the annular abutment member 15, urging it away from the shear-ring. To ensure that there is no relative movement between the parts the bolts 18 are screwed home into the threaded bores 21 in the propeller 10, and locked in position by means of wire which is passed through holes in the heads of the bolts. Figs. 2 and 3 show the arrangement of the parts when this procedure is complete.

Figs. 4 and 5 show an alternative arrangement of a propeller on a tailshaft. A propeller 40 has a substantially cylindrical bore 41 in which is fixed a metallic first sleeve 42. The first sleeve 42 has a substantially cylindrical outer surface of smaller diameter than the bore 41 in the propeller and an inner surface which tapers towards the rear of the propeller. The first sleeve 42 is positioned co-axially within the bore 41 and has been fixed in that position by injecting a hardenable composition including an epoxy resin and carborundum powder into the space between the sleeve 42 and the bore 41 and subjecting the composition to a pressure substantially greater than atmospheric pressure until it hardens. This process for fixing a sleeve inside the bore of a propeller is well-known. Channels 49 for injection of the hardenable compound, air-bleed channels 50 and pressure-balance grooves 51 are provided to enable injection and homogeneous distribution of the compound. A tailshaft 43 is substantially cylindrical and is provided with a closely-fitting metallic second sleeve 44, which is preferably of pearlite cast iron. The outer surface of the second sleeve 44 tapers towards the rear of the tailshaft and is complementary to the tapered inner surface of the first sleeve 42. The second sleeve 44 has an outwardly-directed flange 45 at its forward end which abuts against a flange 46 on the tailshaft 43 and is secured to the flange 46 by means of bolts 58. An inwardly-directed flange 47 at the rear end of the second sleeve 44 abuts against a shoulder 48 on the tailshaft 43.

In Fig. 4 the parts are shown arranged in preparation for the final push-up of the first sleeve 42, together with the propeller 40, along the second sleeve 44. A tyre 52 is arranged in a recess formed between the second sleeve 44 and the propeller 40 by the propeller boss overhanging the aft end of the first sleeve. Te forward face of the tyre 52 engages the rear end of the first sleeve 42. To the rear of the tyre 52 is a ring 53 of harder rubber, the rear face of which engages an annular abutment member 54. To the rear of the annular abutment member 54 is a split shear-ring 55 which abuts the rear shoulder of an annular groove 56 in the tailshaft 43 and is held in position by bolts 57 which screw into threaded holes 64 in the annular abutment member. The arrangement of tyre 52, annular abutment member 54 and split shear-ring 55 in Fig. 4 is similar to that shown in Fig. 1 except that in Fig. 4 the tyre engages a metallic sleeve 42 fixed in a bore in the propeller instead of engaging the propeller itself as shown in Fig. 1.

A pump is used to fill the tyre 52 with oil through a channel 59 in the annular abutment member 54. The tyre is constrained in the radial direction by the propeller and the second sleeve can therefore only expand in an axial direction and acts to push the first sleeve along the second sleeve. As the first sleeve 42 slides along the second sleeve 44 a friction grip is developed between the first sleeve and the second sleeve and between the second sleeve and the tailshaft 43.

When the first sleeve, together with the propeller, has been pushed the desired distance along the second sleeve, the pump is disconnected and oil is allowed to bleed away from the tyre. The annular abutment member 54 is moved forward to abut the propeller 40 and the split shear-ring 55 is removed and replaced in a reversed orientation as described with reference to Figs. 1 to 3. The split shear-ring 55 is rotated such that the bolts 57 pass through larger holes 65 in the annular abutment member 54 and are partly screwed into threaded holes 61 in the propeller in order to support the split shear-ring 55 in position. It should be noted that Fig. 4 is a longitudinal section passing through threaded holes 64 in the annular abutment member and Fig. 5 is a longitudinal section passing through larger holes 65 in the annular abutment member. Screws 60, which run in threaded bores in the split shear-ring 55, are screwed forward to engage the annular abutment member 54 thereby making the assembly of propeller 40, annular abutment member 54 and split shear-ring 55 rigid. The bolts 57 are then screwed home into the threaded holes 61 in the propeller to ensure that the parts do not move relative to one another. Fig. 5 shows the arrangement of the parts on the completion of this procedure.

To remove the propeller 40 from the tailshaft 43 the split shear-ring 55 and the annular abutment member 54 are first removed. Oil is then pumped through a connection 62 in the propeller into grooves 63 cut in the tapered inner surface of the first sleeve 42. As the oil pressure between the first and second sleeve increases, the friction grip between the sleeves is reduced and the first sleeve, together with the propeller, slides off the second sleeve.

It will be appreciated that the invention is not limited to the two examples herein described. The method of securing a propeller by mounting an annular abutment member and a split shear-ring on the tailshaft can be used with other arrangements of propeller and tailshaft, for example arrangements employing a key and keyway to eliminate rotation of the propeller relative to the tailshaft or arrangements in which there is one metallic sleeve between the propeller and the tailshaft.

Furthermore as an alternative to the arrangements for moving the abutment ring forward and securing it in position by means of the shear-rings, the following procedure may be adopted.

After the propeller boss or sleeve has been pushed forward and the oil has been bled from the tyre the split shear ring is removed, the abutment ring is slid back and off the tailshaft and the annular tyre is removed. An incompressible spacer in the form of a cast iron dummy tyre of appropriate axial thickness is slid onto the tailshaft into the recess to replace the nitrile rubber tyre, and the annular ring and shear ring are finally re-assembled on the tailshaft and locked in place to maintain the endwise pressure on the cast iron dummy tyre.

WHAT WE CLAIM IS:—

1. A method for mounting a propeller on a tailshaft of a ship, the method comprising the steps of arranging the propeller on the tailshaft such that a bore in the propeller, or in a metallic sleeve fixed within the propeller, which tapers towards the rear of the propeller engages a complementary tapered portion on the tailshaft, arranging a tyre around the tailshaft in an annular recess which extends forward of the rear face of the propeller whereby the tyre is constrained against expansion in a radial direction, the forward face of the tyre engaging the propeller, or a metallic sleeve fixed within the propeller, and the rear face of the tyre engaging an annular abutment member arranged around the tailshaft, constraining the annular abutment member against movement towards the rear of the tailshaft by mounting a split shear-ring in an annular groove in the tailshaft to the rear of the annular abutment member, and pumping fluid into the tyre whereby it expands and urges the propeller and the annular abutment member apart thereby pushing the propeller along the tailshaft and developing a friction grip between the tapered bore in the propeller or in a metallic sleeve fixed within the propeller and the tapered portion on the tailshaft.

2. A method according to claim 1, and further comprising the steps of releasing the fluid from the tyre after the propeller has been pushed along the tailshaft, removing the split shear-ring, annular abutment member and tyre, mounting an incompressible annular spacer in place of the tyre, and replacing the annular abutment member and split shear-ring to ensure that the propeller does not move towards the rear of the tailshaft during normal use.

3. A method according to claim 1, and further comprising the steps of releasing

the fluid from the tyre, and urging apart the annular abutment member and the split shear-ring whereby the annular abutment member is caused to abut against the propeller with sufficient force to ensure that the propeller does not move towards the rear of the tailshaft during normal use.

4. A method according to claim 3, and including the steps of removing the split shear-ring from the tailshaft after the release of fluid from the tyre and replacing it in a reversed orientation in which the surface which originally faced to the rear faces forward, the shape of the shear-ring being such that when the shear-ring is in the reversed orientation the gap between it and the annular abutment member, when the annular abutment member abuts the propeller, is smaller than the gap when the shear-ring is in the original orientation.

5. A method according to claim 3 or 4, wherein screws in threaded bores in the split shear-ring are used to urge apart from the annular abutment member and the split shear-ring, the screws being directed through the shear-ring in a direction substantially parallel to the tailshaft to engage the annular abutment member.

6. A method according to any of claims 1 to 5, and including the steps of providing a substantially-cylindrical bore in the propeller, positioning a metallic first sleeve co-axially within the bore in the propeller, the first sleeve having a substantially cylindrical outer surface of smaller diameter than the bore in the propeller and an inner surface which tapers towards the rear of the propeller, fixing the first sleeve in the bore in the propeller by injecting a hardenable compoistion into the space between the first sleeve and the bore and subjecting the composition to a pressure substantially cylindrical outer surface on the tailshaft, mounting on the tailshaft a closely-fitting metallic second sleeve having a tapered outer surface complementary to the tapered inner surface of the first sleeve, and pushing the first sleeve, with the propeller, on the second sleeve with sufficient force to provide a friction grip between the first sleeve and the second sleeve and between the second sleeve and the tailshaft.

7. A method according to claim 6, wherein the hardenable composition includes an epoxy resin.

8. A method according to claim 6 or 7, and including the steps of providing at the forward end of the second sleeve an outwardly-directed annular flange, providing an annular flange on the tailshaft, and abutting the flange on the second sleeve against the flange on the tailshaft.

9. A method according to claim 8, and including the step of securing the flange at the forward end of the second sleeve to the flange on the tailshaft.

10. A method according to any of claims 6 to 9, and including the steps of providing at the rear end of the tailshaft a substantially cylindrical portion of smaller diameter than the remainder of the tailshaft whereby a shoulder is provided at the junction of the said portion with the remainder of the tailshaft, and, at the rear end of the second sleeve, an inwardly-directed annular flange, and abutting the last said flange against the said shoulder.

11. A method for mounting a propeller on a tailshaft of a ship, the method including the steps of arranging the propeller on the tailshaft such that a bore in the propeller, or in a metallic sleeve fixed within the propeller, which tapers towards the rear of the propeller engages a complementary tapered portion on the tailshaft, arranging a tyre around the tailshaft such that the forward face of the tyre engages the propeller or a metallic sleeve fixed within the propeller and the rear face engages an annular abutment member arranged around the tailshaft, constraining the annular abutment member against movement towards the rear of the tailshaft by mounting a split shear-ring in an annular groove in the tail-shaft to the rear of the annular abutment member, pumping fluid into the tyre whereby it expands and urges the propeller and the annular abutment member apart thereby pushing the propeller along the tailshaft and developing a friction grip between the tapered bore in the propeller and the tapered portion of the tailshaft, releasing the fluid from the tyre, and urging apart the annular abutment member and the split shear-ring whereby the annular abutment member is caused to abut against the propeller with sufficient force to ensure that the propeller does not move towards the rear of the tailshaft during normal use.

12. An assembly of a propeller on a tailshaft, the propeller, or a metallic sleeve fixed within the propeller, having a bore which tapers towards the rear of the propeller and which engages a complementary tapered portion on the tailshaft, a tyre being arranged around the tailshaft in an annular recess which extends forward of the rear face of the propeller whereby the tyre is constrained against expansion in a radial direction, the forward face of the tyre engaging the propeller, or a metallic sleeve fixed within the propeller, and the rear face of the tyre engaging an annular abutment member which is arranged around the tailshaft, and is constrained against movement towards the rear of the tailshaft by a split shear-ring located to the rear of the annular abutment member in an annular groove in the tailshaft, whereby the propeller can be pushed along the tailshaft by pumping fluid

into the tyre.

13. An assembly according to claim 12, wherein an incompressible annular spacer is provided to replace the tyre when the propeller has been pushed along the tailshaft, thereby ensuring that the propeller does not move towards the rear of the tailshaft during normal use.

14. An assembly according to claim 12, wherein means are provided to urge apart the annular abutment member and the split shear-ring after releasing the fluid from the tyre when the propeller has been pushed along the tailshaft, thereby causing the annular abutment member to abut against the propeller with sufficient force to ensure that the propeller does not move towards the rear of the tailshaft during normal use.

15. An assembly according to claim 14, wherein the split shear-ring can be removed from the tailshaft when the proapeller has been pushed along the tailshaft and can be replaced in a reversed orientation in which the surface which originally faced to the rear faces forward, the shape of the shear-ring being such that when the shear-ring is in the reversed orientation the gap between it and the annular abutment member, when the annular abutment member abuts the propeller, is smaller than the gap when the shear-ring is in the original orientation.

16. An assembly according to claim 14 or 15, wherein the means to urge apart the annular abutment member and the split shear-ring comprise screws in threaded bores in the split shear-ring, the screws being directed through the shear-ring in a direction substantially parallel to the tailshaft to engage the annular abutment member.

17. An assembly according to any of claims 12 to 16, wherein the propeller has a substantially cylindrical bore, co-axially within which bore is fixed a metallic first sleeve having a substantially cylindrical outer surface of smaller diameter than the bore in the propeller and an inner surface which tapers towards the rear of the propeller, the first sleeve having been fixed in the bore in the propeller by injecting a hardenable composition into the space between the first sleeve and the bore and subjecting the composition to a pressure substantially greater than atmospheric pressure until it hardens, the tailshaft having a substantially cylindrical outer surface there being mounted on the tailshaft a closely-fitting metallic second sleeve having a tapered outer surface complementary to the tapered inner surface of the first sleeve, whereby the first sleeve, with the propeller, can be pushed on the second sleeve with sufficient force to provide a friction grip between the first sleeve and the second sleeve and between the second sleeve is mounted on the tailshaft.

18. An assembly according to claim 17, wherein the hardenable composition includes an epoxy resin.

19. An assembly according to claim 17 or 18, wherein there is provided at the forward end of the second sleeve an outwardly-directed annular flange which abuts a flange on the tailshaft when the second sleeve is mounted on the tailshaft.

20. An assembly according to claim 19, wherein the flange at the forward end of the second sleeve is secured to the flange on the tailshaft.

21. An assembly according to any of claims 17 to 20, wherein there is provided at the rear end of the tailshaft a substantially cylindrical portion of smaller diameter than the remainder of the tailshaft whereby a shoulder is provided at the junction of the said portion with a remainder of the tailshaft, and, at the rear end of the second sleeve, an inwardly-directed annular flange which abuts the said shoulder when the second sleeve is mounted on the tailshaft.

22. A method for mounting a propeller on a tailshaft of a ship substantially as herein described with reference to the accompanying drawings.

23. An assembly of a propeller mounted on a tailshaft of a ship substantially as herein described with reference to the accompanying drawings.

24. An assembly of a ship having a propeller mounted on a tailshaft substantially as herein described with reference to the accompanying drawings.

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FIG.1

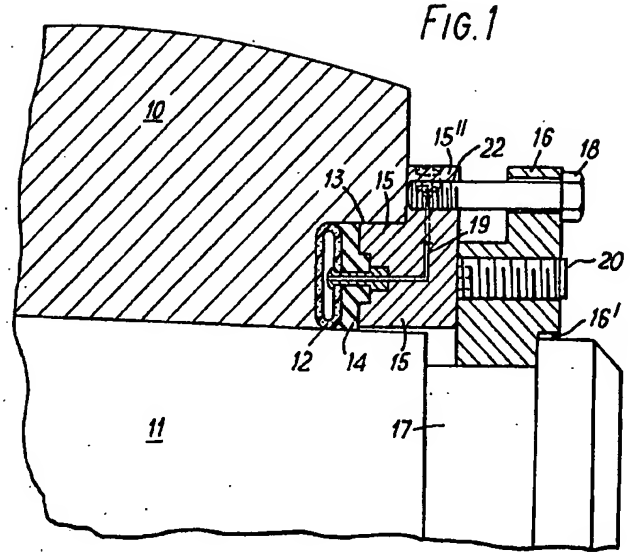

FIG.2

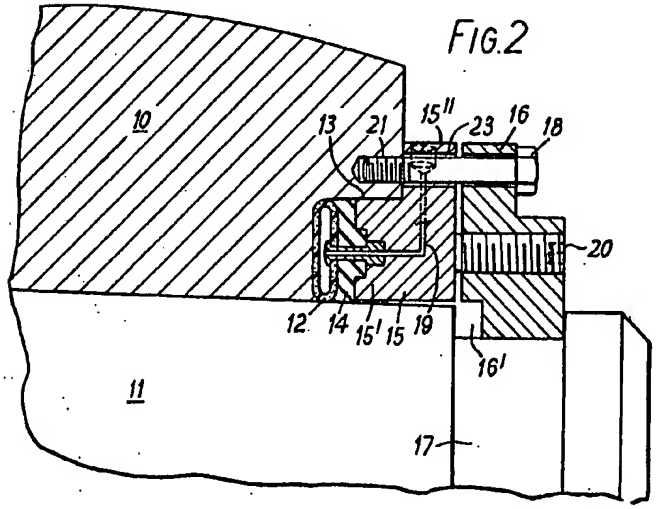

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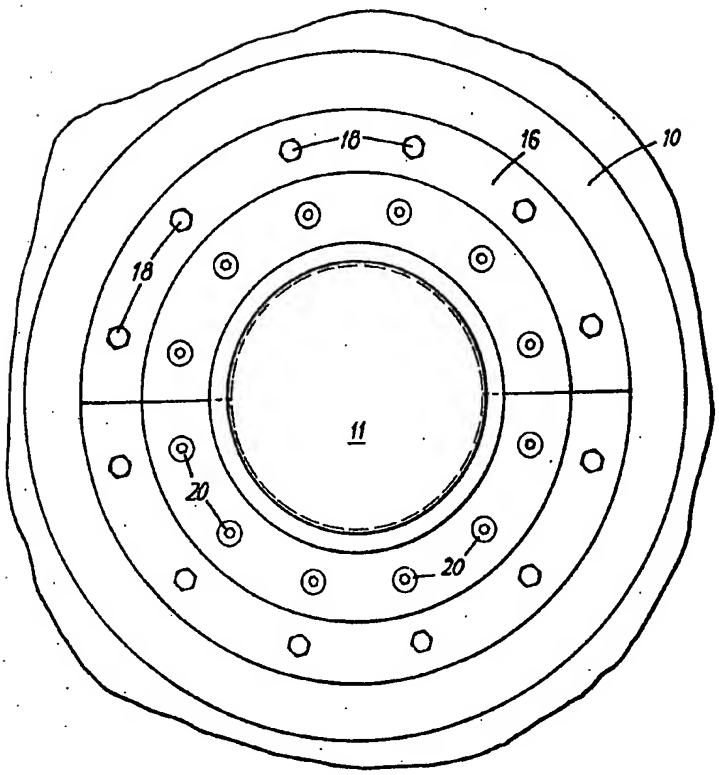
FIG.3



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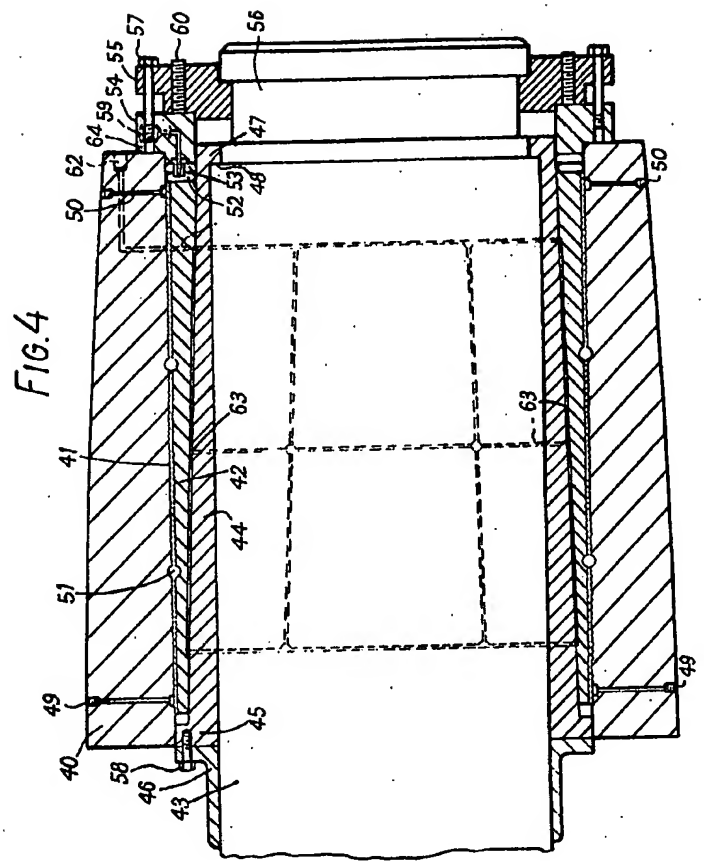

FIG.4

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FIG.5